1. (40 pts) Draw the structure(s) of the major organic product(s) in the following reactions. For partial credit, draw the structure(s) of the major product(s) after each step in a multistep sequence.

A)  
\[ \text{CH}_3\text{OH (xs), H}_2\text{SO}_4 \text{ (cat)} \]
\[ \text{LiAlH}_4, \text{ether, then} \]
\[ \text{aq. workup (H}_3\text{O}^+ \text{ dilute)} \]
\[ \text{1N HCl, H}_2\text{O, THF} \]

B)  
\[ \text{H}_2\text{NNH}_2 \]
\[ \text{KOH, H}_2\text{O, heat} \]

C)  
\[ \text{KCN, (then HCl, aq. workup)} \]
\[ \text{HCl, H}_2\text{O, heat} \]

D)  
\[ \text{PhMgBr (2 eq.), then aq. workup (H}_3\text{O}^+, \text{ dilute)} \]
E) \[
\text{\begin{tikzpicture}
\node[draw, circle] (n1) at (0,0) {};
\end{tikzpicture}}
\]
1) Na$_2$Cr$_2$O$_7$, H$_2$SO$_4$, water, acetone
2) SOCl$_2$
3) CH$_3$NH$_2$, pyridine
4) HCl (pH 1)

F) \[
\text{\begin{tikzpicture}
\node[draw, rectangle, minimum height=1cm] (n1) at (0,0) {};
\end{tikzpicture}}
\]
1) Na$_2$Cr$_2$O$_7$, H$_2$SO$_4$, water, acetone
2) SOCl$_2$
3) CH$_3$NH$_2$, pyridine

G) \[
\text{\begin{tikzpicture}
\node[draw, circle] (n1) at (0,0) {};
\end{tikzpicture}}
\]
1) LiAlH$_4$, ether, then aq. workup (H$_3$O$^+$)
2) \[
\text{\begin{tikzpicture}
\node[draw, circle] (n1) at (0,0) {};
\end{tikzpicture}}
\]

H) \[
\text{\begin{tikzpicture}
\node[draw, circle] (n1) at (0,0) {};
\end{tikzpicture}}
\]
1) CrO$_3$, CH$_2$Cl$_2$, pyridine
2) \[
\text{\begin{tikzpicture}
\node[draw, circle] (n1) at (0,0) {};
\end{tikzpicture}}
\], benzene, reflux
2. (15 pts) Provide a complete, step by step mechanism for the following transformation. Draw the structures of all intermediates formed in the mechanism. (*including resonance structures*).
3. (15 pts) Provide a complete, step by step mechanism for the following transformation. Draw the structures of all intermediates formed in the mechanism (including resonance structures).

\[ \text{Br} \quad \text{Ph}_3\text{P} \quad \text{NaNH} \quad \text{O} \quad \text{Ph}_3\text{P=O} \]
4. (15 pts) Provide a complete, step by step mechanism for the following transformation. Draw the structures of all intermediates formed in the mechanism (*including resonance structures*).

\[ \text{OH} \quad \xrightarrow{\text{HSO}_4^- \text{(cat)}} \quad \text{O} \]

\[ \text{CH}_3\text{CH}_2\text{OH} + \text{H}_2\text{SO}_4 \quad \xrightarrow{\text{xs}} \quad \text{CH}_3\text{CH}_2\text{O} \text{CO} + \text{H}_2\text{O} \]
5. Suggest a sequence of reagents which would accomplish the following transformations. *More than one step will be required.* Draw the structures of all stable products (you do not need to draw reactive intermediates) formed in the proposed reaction sequence. Do not show any mechanisms.

A) \( \text{PhCOOH} \xrightarrow{\text{reagents}} \text{PhOCH}_2\text{CH}₃ \)

B) \( \text{CH}_3\text{CHClCH}₂\text{CH₃} \xrightarrow{\text{reagents}} \text{CH₃CH}₂\text{COOH} \)

C) \( \text{BrPhCOCH}₃ \xrightarrow{\text{reagents}} \text{HOCH}₃\text{COPh} \)